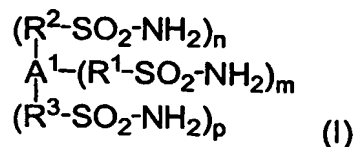


What is claimed is:

1. A fluorinated sulfonamide small molecule having the general structure:



wherein m, n and p are 0 to 3, with the proviso that m + n + p is equal to 1 to 4;

A¹ is an aromatic heterocyclic group, with the proviso that carbon atoms of the heterocyclic ring are fully substituted by fluorinated sulfonamide groups; and

R¹, R², and R³ are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms.

2. The fluorinated sulfonamide small molecule of claim 1 wherein m, n and p are 1 to 2, with the proviso that m + n + p is equal to 1 to 2.

3. The fluorinated sulfonamide small molecule of claim 1 wherein the aromatic heterocyclic group is selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, benzobisimidazole, benzobisoxazole, benzobisthiazole, bibenzimidazole, bibenzoxazole, bibenzothiazole, imidazole, oxazole, thiazole, triazine, tetrazole, pyrazole, triazole, oxadiazole, and thiadiazole.

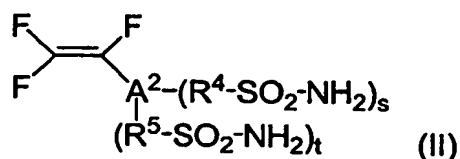
4. The fluorinated sulfonamide small molecule of claim 3 wherein the aromatic heterocyclic group is selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, and triazine.

5. The fluorinated sulfonamide small molecule of claim 1 wherein the aromatic heterocyclic group is benzimidazole.

6. The fluorinated sulfonamide small molecule of claim 1 wherein the linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms contain 1 to 20 carbon atoms.

7. The fluorinated sulfonamide small molecule of claim 6 wherein R¹, R², and R³ are linear perfluoroalkylene groups containing 1 to 6 carbon atoms.

8. A polymerizable perfluorinated or partially fluorinated trifluorovinyl monomer comprising aromatic heterocyclic groups substituted by fluorinated sulfonamide groups and having the general structure:



wherein s and t are the number of fluorinated sulfonamide groups attached to the heterocyclic ring and are equal 0 to 2, with the proviso that s + t is equal to 1 to 2;

A² is an aromatic heterocyclic group, with the proviso that carbon atoms of the heterocyclic ring are fully substituted by either the trifluorovinyl group or the fluorinated sulfonamide groups; and

R⁴ and R⁵ are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms.

9. The polymerizable perfluorinated or partially fluorinated trifluorovinyl monomer of claim 8 wherein the aromatic heterocyclic group selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, benzobisimidazole, benzobisoxazole, benzobisthiazole, bibenzimidazole, bibenzoxazole, bibenzothiazole, imidazole, oxazole, thiazole, triazine, pyrazole, triazole, oxadiazole, and thiadiazole.

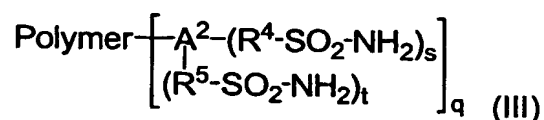
10. The polymerizable perfluorinated or partially fluorinated trifluorovinyl monomer of claim 9 wherein the aromatic heterocyclic group selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, and triazine.

11. The polymerizable perfluorinated or partially fluorinated trifluorovinyl monomer of claim 10 wherein the aromatic heterocyclic group is benzimidazole.

12. The polymerizable perfluorinated or partially fluorinated trifluorovinyl monomer of claim 8 wherein the linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms, contain 1 to 20 carbon atoms.

13. The polymerizable perfluorinated or partially fluorinated trifluorovinyl monomer of claim 12 wherein R⁴ and R⁵ are linear perfluoroalkylene groups containing 1 to 6 carbon atoms.

14. A fluorinated sulfonamide vinyl polymer having the general structure:



wherein Polymer is a polyperfluorocarbon or polypartially fluorinated carbon vinyl polymer backbone optionally containing aromatic side chain groups; q is the mole fraction of fluorinated sulfonamide side chain groups and is selected from 0.01 to 1; s and t are the number of fluorinated sulfonamide groups attached to the heterocyclic ring and are equal 0 to 2, with the proviso that $s + t$ is equal to 1 to 2; A^2 is an aromatic heterocyclic group, with the proviso that the carbon atoms of the heterocyclic ring are fully substituted by the polymer backbone or the fluorinated sulfonamide groups; and R^4 and R^5 are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms.

15. The fluorinated sulfonamide vinyl polymer of claim 14 wherein the aromatic side chain group is phenyl.

16. The fluorinated sulfonamide vinyl polymer of claim 14 wherein Polymer is selected from the group consisting of polytetrafluoroethylene, polytrifluorostyrene, and polychlorotrifluoroethylene.

17. The fluorinated sulfonamide vinyl polymer of claim 14 wherein q is 0.1 to 1.

18. The fluorinated sulfonamide vinyl polymer of claim 17 wherein q is 0.6 to 1.

19. The fluorinated sulfonamide vinyl polymer of claim 14 wherein the aromatic heterocyclic group is selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, benzobisimidazole, benzobisoxazole, benzobisthiazole, bibenzimidazole, bibenzoxazole, bibenzothiazole, imidazole, oxazole, thiazole, triazine, pyrazole, triazole, oxadiazole, and thiadiazole.

20. The fluorinated sulfonamide vinyl polymer of claim 19 wherein the aromatic heterocyclic group is selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, and triazine.

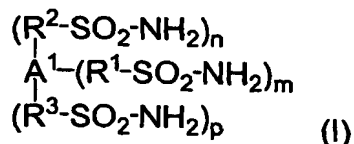
21. The fluorinated sulfonamide vinyl polymer of claim 20 wherein the aromatic heterocyclic group is benzimidazole.

22. The fluorinated sulfonamide vinyl polymer of claim 14 wherein the linear or branched perfluoroalkylene group, optionally containing oxygen, chlorine, bromine, or iodine atoms, contains 1 to 20 carbon atoms.

23. The fluorinated sulfonamide vinyl polymer of claim 20 wherein R^4 and R^5 are linear perfluoroalkylene groups containing 1 to 6 carbon atoms.

24. A polymer electrolyte membrane comprising a compound having fluorinated sulfonamide groups, $-\text{CF}_2-\text{SO}_2-\text{NH}_2$, selected from the group consisting of:

(a) a small molecule having general structure:

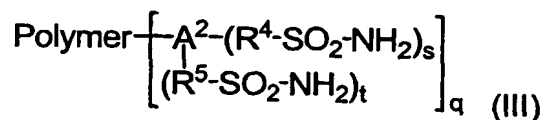


wherein m, n and p are 0 to 3, with the proviso that m + n + p is equal to 1 to 4;

A^1 is an aromatic heterocyclic group, with the proviso that carbon atoms of the heterocyclic ring are fully substituted by fluorinated sulfonamide groups; and

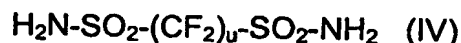
R^1 , R^2 , and R^3 are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms;

(b) a polymer having general structure:



wherein Polymer is a polyperfluorocarbon or polypartially fluorinated carbon vinyl polymer backbone optionally containing aromatic side chain groups; q is the mole fraction of fluorinated sulfonamide side chain groups and is selected from 0.01 to 1; s and t are the number of fluorinated sulfonamide groups attached to the heterocyclic ring and are equal 0 to 2, with the proviso that s + t is equal to 1 to 2; A^2 is an aromatic heterocyclic group, with the proviso that the carbon atoms of the heterocyclic ring are fully substituted by the polymer backbone or the fluorinated sulfonamide groups; and R^4 and R^5 are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms; and

(c) a small molecule having general structure:



wherein u is equal to 1 to 8.

25. The polymer electrolyte membrane of claim 24 wherein compound is a small molecule.
26. The polymer electrolyte membrane of claim 24 wherein compound is a polymer.
27. The polymer electrolyte membrane of claim 25 wherein in structure (I) m, n and p are 1 to 2, with the proviso that $m + n + p$ is equal to 1 to 2.
28. The polymer electrolyte membrane of claim 25 wherein the aromatic heterocyclic group in structure (I) is selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, benzobisimidazole, benzobisoxazole, benzobisthiazole, bibenzimidazole, bibenzoxazole, bibenzothiazole, imidazole, oxazole, thiazole, triazine, tetrazole, pyrazole, triazole, oxadiazole, and thiadiazole.
29. The polymer electrolyte membrane of claim 28 wherein the aromatic heterocyclic group is selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, and triazine.
30. The polymer electrolyte membrane of claim 29 wherein the aromatic heterocyclic group is benzimidazole.
31. The polymer electrolyte membrane of claim 25 wherein in structure (I) the linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms, in structure (I) contain 1 to 20 carbon atoms.
32. The polymer electrolyte membrane of claim 31 wherein R^1 , R^2 , and R^3 are linear perfluoroalkylene groups containing 1 to 6 carbon atoms.
33. The polymer electrolyte membrane of claim 26 wherein the aromatic side chain group in structure (III) is phenyl.
34. The polymer electrolyte membrane of claim 26 wherein Polymer in structure (III) is selected from the group consisting of polytetrafluoroethylene, polytrifluorostyrene, and polychlorotrifluoroethylene.
35. The polymer electrolyte membrane of claim 26 wherein q in structure (III) is 0.1 to 1.
36. The polymer electrolyte membrane of claim 35 wherein q is 0.6 to 1.
37. The polymer electrolyte membrane of claim 26 wherein the aromatic heterocyclic group in structure (III) is selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, benzobisimidazole, benzobisoxazole, benzobisthiazole, bibenzimidazole,

bibenzoxazole, bibenzothiazole, imidazole, oxazole, thiazole, triazine, pyrazole, triazole, oxadiazole, and thiadiazole.

38. The polymer electrolyte membrane of claim 37 wherein the aromatic heterocyclic group is selected from the group consisting of benzimidazole, benzoxazole, benzothiazole, and triazine.

39. The polymer electrolyte membrane of claim 38 wherein the aromatic heterocyclic group is benzimidazole.

40. The polymer electrolyte membrane of claim 26 wherein the linear or branched perfluoroalkylene group, optionally containing oxygen, chlorine, bromine, or iodine atoms, in structure (III) contains 1 to 20 carbon atoms.

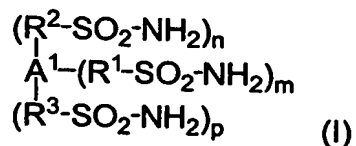
41. The polymer electrolyte membrane of claim 40 wherein R^4 and R^5 are linear perfluoroalkylene groups containing 1 to 6 carbon atoms.

42. The polymer electrolyte membrane of claim 26 wherein u is equal to 2 to 6 in structure (IV).

43. The polymer electrolyte membrane of claim 24 further comprising supporting materials.

44. A membrane electrode assembly comprising a polymer electrolyte membrane, wherein the polymer electrolyte membrane has a first surface and a second surface, and comprises a compound having fluorinated sulfonamide groups, $-\text{CF}_2\text{-SO}_2\text{-NH}_2$, selected from the group consisting of:

(a) a small molecule having general structure:

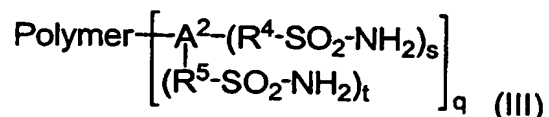


wherein m , n and p are 0 to 3, with the proviso that $m + n + p$ is equal to 1 to 4;

A^1 is an aromatic heterocyclic group, with the proviso that carbon atoms of the heterocyclic ring are fully substituted by fluorinated sulfonamide groups; and

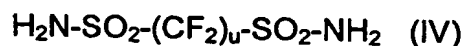
R^1 , R^2 , and R^3 are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms;

(b) a polymer having general structure:



wherein Polymer is a polyperfluorocarbon or polypartially fluorinated carbon vinyl polymer backbone optionally containing aromatic side chain groups; q is the mole fraction of fluorinated sulfonamide side chain groups and is selected from 0.01 to 1; s and t are the number of fluorinated sulfonamide groups attached to the heterocyclic ring and are equal 0 to 2, with the proviso that s + t is equal to 1 to 2; A² is an aromatic heterocyclic group, with the proviso that the carbon atoms of the heterocyclic ring are fully substituted by the polymer backbone or the fluorinated sulfonamide groups; and R⁴ and R⁵ are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms; and

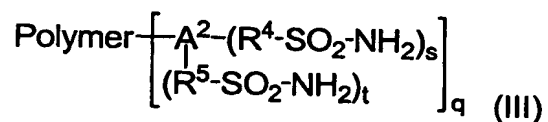
(c) a small molecule having general structure:



wherein u is equal to 1 to 8.

45. The membrane electrode assembly of claim 44 further comprising at least one electrode prepared from an electrocatalyst coating composition present on the first or second surfaces of the membrane.

46. An membrane electrode assembly of claim 45 wherein the electrocatalyst composition comprises a polymer having the general structure:



wherein Polymer is a polyperfluorocarbon or polypartially fluorinated carbon vinyl polymer backbone optionally containing aromatic side chain groups; q is the mole fraction of fluorinated sulfonamide side chain groups and is selected from 0.01 to 1; s and t are the number of fluorinated sulfonamide groups attached to the heterocyclic ring and are equal 0 to 2, with the proviso that s + t is equal to 1 to 2; A² is an aromatic heterocyclic group, with the proviso that the carbon atoms of the heterocyclic ring are fully substituted by the polymer backbone or the fluorinated sulfonamide

groups; and R^4 and R^5 are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms.

47. The membrane electrode assembly of claim 46 wherein the electrocatalyst composition further comprises a catalyst.

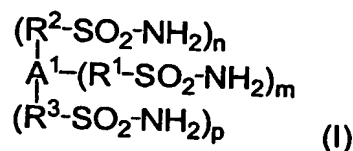
48. The membrane electrode assembly of claim 45 further comprising at least one gas diffusion backing adjacent at least one electrode present on the polymer electrolyte membrane.

49. The membrane electrode assembly of claim 44 further comprising at least one gas diffusion electrode present on the first or second surfaces of the membrane, wherein the gas diffusion electrode comprises a gas diffusion backing with an electrode prepared from an electrocatalyst coating composition.

50. An electrochemical cell comprising a polymer electrolyte membrane having a first surface and a second surface, wherein the polymer electrolyte membrane comprises a compound having fluorinated sulfonamide groups,

$-\text{CF}_2-\text{SO}_2-\text{NH}_2$, selected from the group consisting of:

(a) a small molecule having general structure:

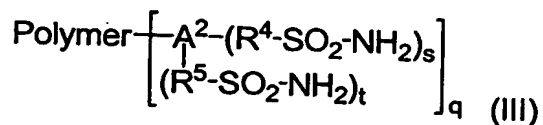


wherein m , n and p are 0 to 3, with the proviso that $m + n + p$ is equal to 1 to 4;

A^1 is an aromatic heterocyclic group, with the proviso that carbon atoms of the heterocyclic ring are fully substituted by fluorinated sulfonamide groups; and

R^1 , R^2 , and R^3 are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms;

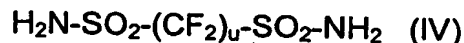
(b) a polymer having general structure:



wherein Polymer is a polyperfluorocarbon or polypartially fluorinated carbon vinyl polymer backbone optionally containing aromatic side chain

groups; q is the mole fraction of fluorinated sulfonamide side chain groups and is selected from 0.01 to 1; s and t are the number of fluorinated sulfonamide groups attached to the heterocyclic ring and are equal 0 to 2, with the proviso that $s + t$ is equal to 1 to 2; A^2 is an aromatic heterocyclic group, with the proviso that the carbon atoms of the heterocyclic ring are fully substituted by the polymer backbone or the fluorinated sulfonamide groups; and R^4 and R^5 are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms; and

(c) a small molecule having general structure:



wherein u is equal to 1 to 8.

51.. The electrochemical cell of claim 50, wherein the electrochemical cell is a fuel cell.

52. The fuel cell of claim 51 further comprising an anode and a cathode present on the first and second surfaces of the polymer electrolyte membrane.

53. The fuel cell of claim 52 further comprising a gas diffusion backing adjacent each of the anode and the cathode.

54. The fuel cell of claim 51 further comprising gas diffusion electrodes comprising a gas diffusion backing with an anode and a gas diffusion backing with a cathode present on the first and second surfaces of the polymer electrolyte membrane, wherein the anode and cathode are adjacent the polymer electrolyte membrane.

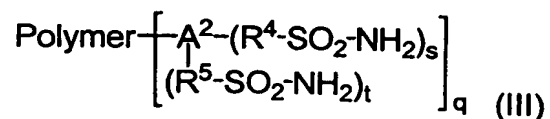
55. The fuel cell of claim 51 further comprising a means for delivering fuel to the anode, a means for delivering oxygen to the cathode, a means for connecting the anode and cathode to an external electrical load, fuel in the liquid or gaseous state in contact with the anode, and oxygen in contact with the cathode.

56. The fuel cell of claim 55 wherein the fuel is hydrogen.

57. The fuel cell of claim 55 wherein the fuel is an alcohol.

58. The fuel cell of claim 57 wherein the fuel is methanol.

59. An electrocatalyst composition comprising a polymer having the general structure:



wherein Polymer is a polyperfluorocarbon or polypartially fluorinated carbon vinyl polymer backbone optionally containing aromatic side chain groups; q is the mole fraction of fluorinated sulfonamide side chain groups and is selected from 0.01 to 1; s and t are the number of fluorinated sulfonamide groups attached to the heterocyclic ring and are equal 0 to 2, with the proviso that $s + t$ is equal to 1 to 2; A^2 is an aromatic heterocyclic group, with the proviso that the carbon atoms of the heterocyclic ring are fully substituted by the polymer backbone or the fluorinated sulfonamide groups; and R^4 and R^5 are linear or branched perfluoroalkylene groups, optionally containing oxygen, chlorine, bromine, or iodine atoms.

60. The electrocatalyst composition of claim 59 further comprising a catalyst.